UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

September 28, 2022

Brad R. Bingham
Closure Manager
Grants Reclamation Project
Homestake Mining Company of California
P.O. Box 98/Highway 605
Grants, NM 87020

SUBJECT: U.S. NUCLEAR REGULATORY COMMISSION STAFF ACCEPTANCE REVIEW OF THE HOMESTAKE MINING COMPANY OF CALIFORNIA REQUEST FOR AMENDMENT TO LICENSE SUA-1471 FOR THE LARGE TAILINGS PILE EVAPOTRANSPIRATION COVER DESIGN DOCKET NO. 04008903

Dear Brad Bingham:

By letter dated March 21, 2022,[1] the Homestake Mining Company of California (HMC) submitted a license amendment request (LAR) to the U.S. Nuclear Regulatory Commission (NRC) staff for review and approval. Specifically, HMC is proposing to change the large tailings pile (LTP) cover design from the currently approved rock cover to an evapotranspiration (ET) cover. The ET cover design change would only apply to the top of the LTP, not the completed side slopes. In correspondence dated April 21, 2022,[2] the NRC staff identified that no environmental information was included in the LAR. By letter dated May 17, 2002,[3] HMC submitted an Environmental Report to support the LAR.

After receipt of the complete LAR, the NRC staff performed an acceptance review to determine if the LAR contained sufficient technical information to conduct a detailed technical review. The NRC staff has determined that the LAR does not provide sufficient technical information to conduct a detailed review.

The NRC staff is providing comments in the Enclosure that were developed during the acceptance review that may assist HMC to develop an application acceptable for technical review. If HMC sufficiently addresses the NRC comments provided in an updated application, the NRC staff will expedite the acceptance review process. The NRC staff acknowledges there is limited NRC guidance on the design and construction of ET covers. There are a growing number of publications on the design, construction, and performance of ET covers that the NRC staff used to develop its comments.

In accordance with Title 10 of the *Code of Federal Regulations* 2.390, "Public inspections, exemptions, requests for withholding," of the NRC's "Agency Rules of Practice and Procedure," a copy of this letter will be available electronically for public inspection in the NRC Public

[1] Agencywide Documents Access and Management System (ADAMS) Accession No. ML22080A186
[2] ML22117A064
[3] ML22139A146

Document Room or from the Publicly Available Records component of NRC's Agencywide Documents Access and Management System. ADAMS is accessible from the NRC Web site at https://www.nrc.gov/reading-rm/adams.html.

If you have any questions regarding this matter, please contact me at 301-415-7777, or via email at Ron.Linton@nrc.gov.

Sincerely,

Signed by Linton, Ron
on 09/28/22

Ron C. Linton, Project Manager
Uranium Recovery and Materials
Decommissioning Branch
Division of Decommissioning, Uranium Recovery
and Waste Programs
Office of Nuclear Material Safety
and Safeguards

Docket No.: 040-08903
License No.: SUA-1471

Enclosure:
NRC staff comments

Cc via Homestake ListServ:
Mark Purcell (EPA)
Anne Maurer (NMED)
Bill Frazier (DOE)
Ian Hewitt (OSE)

U.S. Nuclear Regulatory Commission Comments
Homestake Mining Co. of California, Grants Reclamation Project
Large Tailings Pile Evapotranspiration Cover
License Amendment Request

The U.S. Nuclear Regulatory Commission (NRC) staff is providing the following comments that were developed during the acceptance review that may assist the Homestake Mining Company of California (HMC) with developing an application acceptable for technical review. The comments generally correspond to the Chapters in the license amendment request (LAR) where the subject is first discussed. For example, Comment (Com) 3-1, corresponds to information contained in Chapter 3 of the LAR.

Com 3-1

Evaluate the dispersive potential of the test pit soils proposed for the evapotranspiration (ET) cover system[1] with respect to plant growth and soil erosion and the implications for cover design.

Discussion

Dispersive soils are prone to water erosion (leading to gullying, piping) and compaction when wet (resulting in a reduction in soil pore space, which can restrict plant growth). The results of the borrow soil agronomic laboratory testing, provided in Table 2 of Appendix C of the LAR, suggest that most of the soils are dispersive. The pH of the 18 samples tested in Table 2 of Appendix C range from 7.76 to 10.01. According to Hauser (2009),[2] soils with pH of 8.3 and higher "may contain excess sodium, and at pH above 9, the soil probably contains excess sodium, which disperses both clay and organic matter" and that "few, if any plants grow in these soils." Furthermore, using a relationship between percent sodium and total dissolved salts in saturation and dispersive potential (U.S. Bureau of Reclamation (USBR), 1991 (see Com 3-1, Figure 1))[3] indicates that samples TP1-A, B and C; TP2-D; TP3-B, C and D; TP4-D; TP5-B, C are dispersive. Samples TP2-A, B, C and TP5-A are characterized as having an intermediate dispersive potential, while only samples TP3-A and TP4-A, B, C are non-dispersive (see Com 3-1, Table 1, developed by the NRC staff based on data from the LAR).

[1] This could also impact the radon barrier layer.
[2] Hauser, V. L. (2009). *Evapotranspiration Covers for Landfills and Waste Sites*. CRC Press, Boca Raton, Florida.
[3] U.S. Bureau of Reclamation (1991). *Characteristics and Problems of Dispersive Clay Soils*. Dated October.

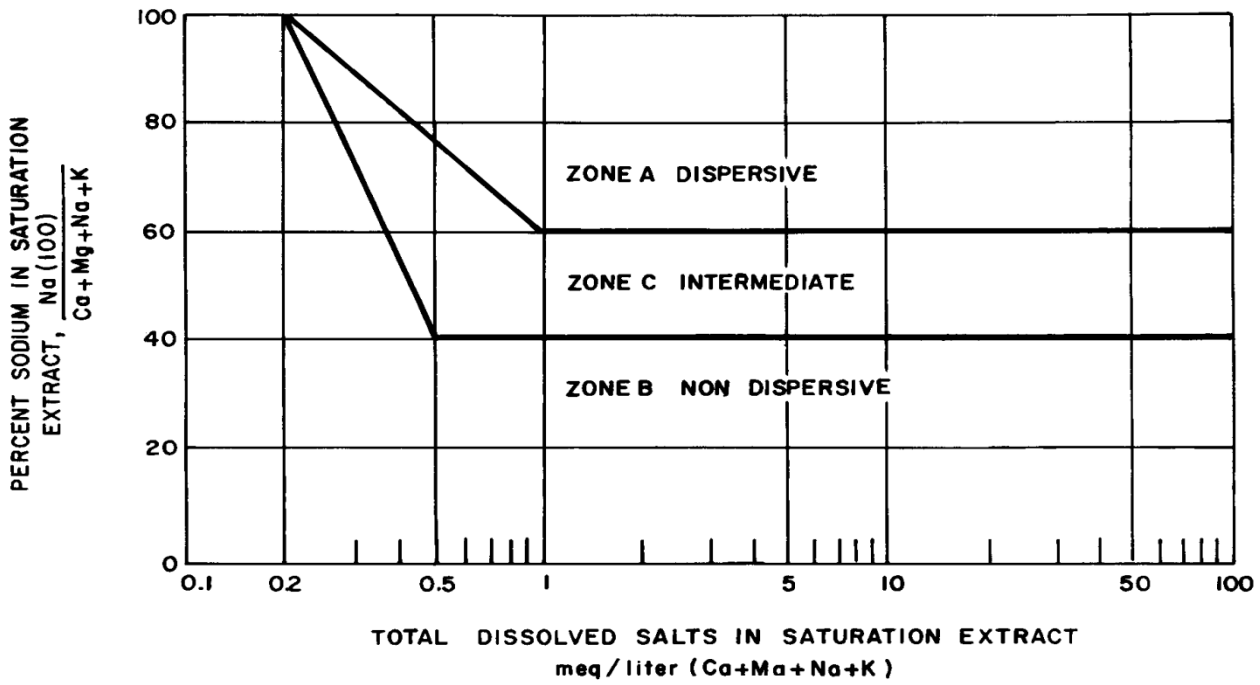

Figure 1. Dispersive Potential vs. Total Dissolved Salts (Source: Figure 4 of USBR, 1991)

Sample	Depth (in)	Texture (USDA)	pH	Concentration (meq/L)						% Na	Dispersive Potential
				Ca	Mg	Na	K	SAR	TDS		
TP1-A	0-10	clay	8.66	0.8	0.1	8.0	0.0	11.9	8.9	89.9	Dispersive
TP1-B	10-60	clay	8.84	1.2	0.2	9.2	0.0	11.0	10.6	86.8	Dispersive
TP1-C	60-100	clay	9.11	0.6	0.1	7.2	0.0	12.2	7.9	91.1	Dispersive
TP2-A	0-9	clay	8.04	3.0	0.8	3.0	0.2	2.2	7.0	42.9	Intermediate
TP2-B	9-19	clay	7.91	7.0	2.7	8.2	1.8	3.7	19.7	41.6	Intermediate
TP2-C	19-96	clay	8.65	0.8	0.2	1.2	0.0	1.7	2.2	54.5	Intermediate
TP2-D	96-110	clay	8.57	1.1	0.3	2.4	0.0	2.9	3.8	63.2	Dispersive
TP3-A	0-6	clay loam	7.76	21.7	5.5	3.1	0.3	0.8	30.6	10.1	Non-Dispersive
TP3-B	6-48	clay loam	8.4	1.7	0.9	15.3	0.1	13.4	18.0	85.0	Dispersive
TP3-C	48-84	clay loam	9.56	1.3	2.9	22.8	0.1	15.7	27.1	84.1	Dispersive
TP3-D	84-132	clay loam	10.01	0.4	0.1	18.2	0.0	36.4	18.7	97.3	Dispersive
TP4-A	0-7	sandy clay loam	8.29	1.2	0.2	0.7	0.3	0.8	2.4	29.2	Non-Dispersive
TP4-B	7-14	sandy clay loam	8.23	1.4	0.3	0.5	0.1	0.5	2.3	21.7	Non-Dispersive
TP4-C	14-48	sandy clay loam	8.26	1.4	0.4	0.8	0.1	0.8	2.7	29.6	Non-Dispersive
TP4-D	48-84	sandy clay loam	8.86	0.4	0.2	5.2	0.0	9.5	5.8	89.7	Dispersive
TP5-A	0-6	clay	8.06	16.1	3.6	17.8	0.3	5.7	37.8	47.1	Intermediate
TP5-B	6-32	clay	8.2	8.6	2.0	26.6	0.1	11.6	37.3	71.3	Dispersive
TP5-C	32-72	clay	8.08	14.9	3.3	35.0	0.1	11.6	53.3	65.7	Dispersive

Table 1. Dispersive Soil Properties of the Test Pits (Data from Table 2 in the LAR Appendix C).

Basis

Appendix A, "Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material From Ores Processed Primarily for Their Source Material Content," to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 40, "Domestic Licensing of Source Material," Criterion 4(d) requires that a full self-sustaining vegetative cover must be established or rock cover employed to reduce wind and water erosion to negligible levels. Criterion 4 also states that "overall stability, erosion potential, and geomorphology of surrounding terrain must be evaluated to assure that there are not ongoing or potential processes, such as gully erosion, which would lead to impoundment instability"; this requirement would apply to the nearby North Borrow source which is the proposed source for the cover materials. Furthermore, NUREG-1623, "Design of Erosion Protection for Long-Term Stabilization," states that dispersive soils should not be used.

Com 3-2

Determine suitable pH ranges for the proposed ET cover soils.

Discussion

The proposed soils are observed by the NRC staff to have high pH values that may affect the ability of the ET cover to support vegetation. The availability of essential plant nutrients and the phytotoxicity of metals and other elements are highly responsive to soil pH (Albright et al., 2010).[4] According to Hauser (2009), "soils with excessively high pH are difficult or impossible to remediate" and that "plants grow best in soils with neutral pH in the range of 6-7.5." The pH of the 18 samples tested in Appendix C, Table 2, range from 7.76 to 10.01. Furthermore, the pH for sample TP1-A is 8.66, which is being proposed for the gravel-amended soil layer and possibly the ET cover soil layer.[5] Table 1 of Appendix C of the LAR provides desired ranges for each tested parameter (including soil pH); a pH range of 6-8.3 is listed. Similar ranges are also provided by other ET cover guidelines. For example, a pH range of 6.0-8.4 is specified by the Colorado Department of Public Health and Environment (CDPHE) (2013).[6] A pH upper limit of 8.4 is also suggested by Munshower (1994).[7]

Basis

Appendix A to 10 CFR Part 40, Criterion 4(d) requires that a full self-sustaining vegetative cover must be established or rock cover employed to reduce wind and water erosion to negligible levels.

Com 3-3

a) Provide the calcium carbonate ($CaCO_3$) values for the borrow soil samples shown in Table 2 of the LAR Appendix C.

---

[4] Albright, B., Benson, C. and Waugh., J. (2010). *Water Balance Covers for Waste Containment*. American Society of Civil Engineers (ASCE), Reston, Virginia.
[5] See Com 4-1, which requests clarity on the use of TP1-A for this layer.
[6] Colorado Department of Public Health and Environment (2013). *Final Guidance Document, Water Balance Covers in Colorado*. Dated March.
[7] Munshower, F. (1994). *Practical Handbook of Disturbed Land Revegetation*. CRC Press, Boca Raton, Florida.

b) Discuss the $CaCO_3$ values with respect to supporting plants on the proposed ET cover.

Discussion

Chapter 2 of the LAR Appendix C states that laboratory testing focused on foundational chemical and physical properties that are vital to the establishment and sustainability of vegetation on reclamation units and that parameter testing included percent $CaCO_3$. However, $CaCO_3$ values are missing from Table 2 of Appendix C. With respect to appropriate values, the ET cover guidance developed by CDPHE (2013), for example, specifies that $CaCO_3$ content should be less than 15 percent by weight.

Basis

Appendix A to 10 CFR Part 40, Criterion 4(d) requires that a full self-sustaining vegetative cover must be established or rock cover employed to reduce wind and water erosion to negligible levels.

Com 3-4

a) Justify the selection of a maximum value of 50 percent for clay content in Figure 1 of the LAR Appendix C rather than a lower value, such as the upper limit of a clay loam of 40 percent.

b) Specify the optimal and acceptable ranges of clay content that will comprise the proposed ET cover soil and update Appendix F (Construction Specifications) accordingly. This discussion should also take into consideration the optimal soil conditions for the proposed ET cover vegetation.

c) Provide the proposed clay content ranges of the radon barrier component.

Discussion

Most plants grow best in soils that have balanced proportions of sand, silt and clay such as loams, clay loams, and sandy loams (Albright et al., 2010). Figure 1, in the LAR Appendix C, displays the U.S. Department of Agriculture (USDA) textural classification system and highlights unsuitable textural designations in red, which is greater than 50 percent for clay content. Chapter 2.1 of the LAR Appendix C states that revegetation establishment and persistence can be affected by heavy clay soils while noting that Test Pit #2 exhibits clay proportions that are elevated beyond the optimal ranges for reclamation growth media. Furthermore, Chapter 3.5 of the LAR Appendix B notes that heavy clay soils used in the plant rooting zone, particularly as topsoil, may impact revegetation potential. However, the LAR or Construction Specifications (Appendix F) do not specify clay content for the proposed ET cover soils.

Basis

Appendix A to 10 CFR Part 40, Criterion 4(d) requires that a full self-sustaining vegetative cover must be established or rock cover employed to reduce wind and water erosion to negligible levels.

Com 3-5

a) Provide the particle-size distributions for the test pit samples from the North Borrow location.

b) Specify appropriate limits on particle size for the ET cover soil layers.

Discussion

It is common to add a gravel admix layer to the top of the water storage layer to minimize erosion from wind and water (Waugh et al., 1994).[8] However, particle-size distribution influences water infiltration, hydraulic conductivity, water storage capacity and cation exchange capacity (Albright et al., 2010). According to Hauser (2009), soils containing gravel and rock (i.e., particles larger than 2 mm) may be unsuitable for use in ET cover soil as they can reduce the water holding capacity and dilute the nutrient-supplying capacity of the soil. ET cover guidance developed by the CDPHE (2013) recommends that the soil used for the cover contain less than or equal to 15 percent gravel (i.e., greater than 2 mm, retained on the No. 10 sieve) in addition to limiting the maximum particle size to less than 2 inches in the longest dimension.

As stated in Chapter 3.2 of the LAR (and show in Chapter 3.2, Table 1), the soil samples collected from the test pits were tested for percent fines (passing No. 200 sieve). Only samples of gravel, from the rock mulch stockpile, were tested for particle-size distribution. Particle-size distributions should also be provided for the proposed ET cover soil layer (including the soil used in the gravel-amended soil layer). According to Section 310000 of Appendix F of the LAR, soil cover shall consist of suitable materials from the approved borrow areas, with no cobbles or rock larger than 1.5 inches. However, no other particle-size specifications are provided. Particle-size information is also required for the wind erosion calculations in the LAR Chapter 4.4.3 (see Com 4-13).

Basis

Appendix A to 10 CFR Part 40, Criterion 4(d) requires that a full self-sustaining vegetative cover must be established or rock cover employed to reduce wind and water erosion to negligible levels.

Com 3-6

a) Discuss the potential for biointrusion at the site by documenting the types of burrowing animals or insects that have been observed in the site vicinity or could potentially inhabit the site in the future.

b) Provide information on deepest depths and volumes of burrows they might be expected to excavate, and maximum rock sizes that have been shown to deter such burrowing by these animals at other sites (if available). The impact of deep-rooted plants (i.e., invasive species or proposed ET cover species) over the service life of the cover should also be considered in this discussion.

[8] Waugh, W.J., Thiede, M.E., Bates, D.J., Cadwell, L.L., Gee, G.W., and Kemp, C.J., 1994b, Plant Cover and Water-Balance in Gravel Admixtures at an Arid Waste-Burial Site: Journal of Environmental Quality, v. 23, no. 4, p. 676-685.

c) Discuss the protective measures (e.g., rock material, adequate soil thickness) that have been incorporated in the cover design to minimize cover degradation from burrowing and root penetration.

d) Discuss the impact of a potentially degraded cover on the results of the ET cover modeling as well as the radon flux calculations

Discussion

The NRC staff observed numerous animal burrows on the large tailings pile (LTP) during a site visit in February 2022. Furthermore, several of the plant species proposed for the ET cover (shown in the LAR, Appendix C, Table 3), have maximum rooting depths that could exceed the depth to the tailings –notably Fourwing Saltbush (see Com 3-6, Table 2, below, which shows maximum observed rooting depths for some of the proposed plant species). According to Chapter 3 of the LAR Appendix C, a mixed shrub/grass vegetation community is expected to colonize the ET cover over the next 1,000 years and will be composed primarily of Fourwing Saltbush at 50 percent dominance and a mixture of warm and cool season perennial grasses at 50 percent dominance. A discussion of potential root depth is provided in Chapter 3.3 of the LAR Appendix C with respect to the Church Rock site. However, it is not clear which the types of plants were sampled as well as the soil conditions. Com 3-7 requests the applicant to provide supplemental information related to the use of the Church Rock Mill site as a reference site.

In addition to unearthing buried waste, burrowing animals and invertebrates can alter physical and hydraulic soil properties that influence erosion and the soil water balance of covers (Albright et al., 2010). Williams et al., (2022)[9] observed that radon fluxes were higher in regions where woody vegetation or aggressive insects had established on select Uranium Mill Tailings Radiation Control Act (UMTRCA) covers, which they attributed to soil structure induced by root activity and insect burrowing in the radon barrier, as well as higher radon diffusion coefficients associated with lower water saturation in areas influenced by root water update.

[9] Williams, M., Fuhrmann, M., Stefani, M, Michaud, A., Likos, W., Benson, C., and Waugh, W. (2022). *Evaluation of In-Service Radon Barriers over Uranium Mill Tailings Disposal Facilities.* Vol. 1, NUREG/CR-7288, U.S. Nuclear Regulatory Commission Report.

Homestake Recommended Seed Mix[10]	
Common Name	**Maximum Rooting Depth (ft)[11]**
Western Wheatgrass	5.41
Alkali Sacaton	-
Blue Grama	3.02
Galleta	-
Thickspike Wheatgrass	4.99
Indian Ricegrass	> 4.92
Sideouts Grama	6
Bottlebrush Squirreltail	2.46
Scarlet Globemallow	5.91
Palmer Penstemon	-
Rocky Mtn. Penstemon	-
Lewis Flax	-
Fourwing Saltbush	39.37
Wyoming Big Sagebrush	6
Sand Sage	10.99
Winterfat	30.18

Table 2. Proposed Vegetation for the HMC ET Cover.

Basis

Appendix A to 10 CFR Part 40, Criterion 4(d) requires that a full self-sustaining vegetative cover must be established or rock cover employed to reduce wind and water erosion to negligible levels. In addition, Criterion 6(1) establishes the radon flux standards for tailings piles. The regulation requires that the NRC staff has reasonable assurance that the design will limit radon flux to 20 pCi/m^{2}s and be effective for 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years.

Com 3-7

a) Justify the use of the reclaimed plant community from the vicinity of the Church Rock Mill site as a reference site for the proposed Homestake ET cover vegetation, rather than the North Borrow pit area (or a similar nearby undisturbed area). Supporting information should include a detailed comparison of the soils, native vegetation, and climate between the Church Rock Mill site and the Homestake North Borrow pit area (or a similar nearby undisturbed area).

b) Provide the ecological basis for the revegetation success criteria described in the LAR Chapter 7.2 and Chapter 6.2 of the LAR Appendix C.

c) Provide the time frames for the revegetation target values.

d) Discuss how the proposed revegetation success criteria will compare to the reference area or analog site.

[10] The recommended seed mix is from Chapter 7.1.2, Table 8, and Appendix C, Table 3, of the LAR.
[11] https://groundwaterresourcehub.org/sgma-tools/gde-rooting-depths-database-for-gdes.

Discussion

One of main objectives of cover revegetation is to create a soil environment similar to nearby undisturbed areas (reference areas or analog sites) and establish plant communities that are well adapted to that environment (Albright et al., 2010). The reference area or analog site can also be used to assess the revegetation success of the ET cover.

As referenced in Chapter 7 of the LAR, the Homestake ET cover revegetation plan is provided in Appendix C of the LAR. Chapter 3 of Appendix C states the following: "The site-specific sampling at the Church Rock Mill site, approximately 45 miles to the northwest, is a suitable source to reference because the reclaimed analog represents the vegetation community assemblage and corresponding parameters expected on the Homestake ET cover." However, neither Appendix C, nor Chapter 7 of the LAR, provide a comparison between the two sites to support this statement. Although not directly referenced in the text of Appendix C, a Cedar Creek report[12] is listed in Chapter 8 (References) of the LAR Appendix C. This report should be directly referenced in the LAR, where appropriate, so that the NRC can review the Church Rock Mill site information in the context of the proposed Homestake ET cover. Furthermore, the report should be provided as an Appendix to the LAR since it forms the technical basis for the Homestake ET cover.

Basis

Appendix A to 10 CFR Part 40, Criterion 4(d) requires that a full self-sustaining vegetative cover must be established or rock cover employed to reduce wind and water erosion to negligible levels.

Com 4-1

a) Specify which test pits will be sourced from the North Borrow pit area for use as the ET cover soil layer (i.e., 0 to 0.75' (feet) and 0.75' to 1.59' in Chapter 4.0, Figure 3 of the LAR) and also below 1.59' to depth of 4.59'.

b) Based on the response to part a), discuss the suitability of the selected test pits in terms of supporting vegetation and storing water.

c) Determine if quantities of this material exist to support the construction of the ET cover soil layer.

d) Justify the use of TP1-A for the gravel-amended soil layer (and potentially other layers within the cover) given this sample's high pH, dispersive potential, and high clay content.

Discussion

Chapter 4.1.1 of the LAR states that the gravel-amended soil layer will be constructed with topsoil stripped from the borrow area that has characteristics consistent with the soil from TP1-A (0'-4'). However, there is no mention of which soils will be used to construct the 1.59' thick soil layer below this gravel-amended soil layer. With respect to inputs used in the SEEP/W analysis,

[12] Cedar Creek Associates, Inc. *Northeast Church Rock Mill Site, Vegetation Characterization And Biointrusion Surveys*, July, 2014.

the LAR states that all layers within the cover were assigned the hydraulic properties associated with TP1-A (0'-4'). However, it is not clear if TP1-A soils will also be used in the actual construction of the cover layers below 0.75'. HMC should provide a discussion regarding which TP soils are intended for the ET cover soil layer (including their suitability). This discussion should also include a comparison of the target soil properties (and test pits) that were originally proposed for the radon barrier and frost protection layer (referred to in Chapter 4.2 of the LAR as ERG, 1995) and how these properties compare to the test pit soils described in Chapter 3 of the LAR.

Basis

Appendix A to 10 CFR Part 40, Criterion 6(1) requires that the NRC staff has reasonable assurance that the design be effective for 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years. Additionally, Criterion 12 requires that the final disposition of the tailings should not require ongoing active maintenance to preserve isolation.

Com 4-2

a) Explain why the original frost protection layer was modeled in the SEEP/W analysis rather than the ET cover soil layer.

b) Justify the use of identical properties for the ET cover soil layer (modeled as the frost protection layer) and the radon barrier in the SEEP/W analysis as shown in Chapter 4.1.1, Table 2, of the LAR. The ET cover soil layer and a radon barrier would be expected to have quite different properties.

c) Justify the use of a value of 4.3×10^{-5} cm/s to represent the long-term saturated hydraulic conductivity (K_{sat}) of the ET cover below a depth of 0.75' to represent the saturated hydraulic conductivity of in-service covers.

Discussion

The LAR Chapter 4.1.1 states that "the properties from TP1-A (0'-4') were assigned to all layers in the cover for the SEEP/W analysis because this soil has the highest hydraulic conductivity of the fine-grained soils that were tested and is suitable for the frost protection layer and radon barrier. Thus, predictions with SEEP/W would be conservative using hydraulic properties from TP1-A (i.e., higher percolation rates) relative to other fine-grained soils on the site." This statement needs further explanation; as written, it implies that the radon barrier and the ET cover soil layers are identical. Expected differences would include the soil density, compaction, porosity, K_{sat} and soil water characteristic curve parameters.

With respect to the K_{sat} values assigned as inputs, the SEEP/W predictions may not be conservative as the effects of pedogenic processes such as biota intrusion, desiccation, and freeze-thaw cycling could extend beyond the 0.75' depth. As described in the LAR Chapter 4.1.1, a K_{sat} of 1.0×10^{-3} was assigned to the surficial gravel-amended soil layer to represent a structured near surface, as described in NUREG/CR-7028. Below a depth of 0.75', the ET cover soil layer and radon barrier were assigned a K_{sat} of 4.3×10^{-5}. Based on a study of the saturated hydraulic conductivities of in-service ET covers as part of the Alternative Covers Assessment Program, Albright et al., (2010) recommend that the upper 300 mm (0.98') of the storage layer

should have saturated hydraulic conductivities ranging between 10^{-4} to 10^{-3} cm/s. Williams et al., (2022) evaluated the in-service conditions radon barriers at four UMTRCA sites and observed that the saturated hydraulic conductivities were 2 to 3 orders of magnitude higher than the common $1x10^{-7}$ cm/s design criterion established for low-conductivity radon barriers regardless of depth or thickness of the cover or radon barrier.

Basis

Appendix A to 10 CFR Part 40, Criterion 6(1) requires that the NRC staff has reasonable assurance that the design be effective for 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years. Additionally, Criterion 12 requires that the final disposition of the tailings should not require ongoing active maintenance to preserve isolation.

Com 4-3

Provide a detailed discussion of the performance objectives of the ET cover. This discussion should specify the ET cover design percolation rate (i.e., percolation from the base of the cover), the basis for the selection of this rate, and how the ET cover will be monitored in the short-term to ensure that it performs as designed.

Discussion

Albright et al., (2010) note that one of the first steps in designing an ET cover is "deciding the performance objectives, which generally include a maximum percolation rate." The LAR Chapter 4.0 states that "the ET cover design was evaluated in the context of three primary criteria: percolation into the underlying tailings, radon emanation, and erosion control." With respect to percolation, Chapter 4.1 of the LAR states "the objective of the modeling was to predict the long-term percolation rate anticipated for the cover." However, the LAR does not specify a design percolation rate along with the impact of the percolation rate from the cover on long-term risks associated with groundwater contamination. For example, test covers in the Alternative Covers Assessment Program were designed to have a percolation rate of less than 3 mm/year.

Albright and others (2004)[13] found ET covers to be highly effective in subhumid, semiarid, and arid sites where percolation was <0.4 percent of precipitation, or <2.2 mm/year. Although 5 out of the 10 covers in arid, semiarid, and subhumid climates transmitted less than 0.1 mm of percolation, two transmitted much more percolation (i.e., 26.8 and 52 mm) than anticipated during design. This observation illustrates the importance of performance monitoring. Albright et al., 2010 emphasize the importance of performance monitoring of covers due to the inherent uncertainty in performance predictions and because the engineering properties of cover materials change over time; they recommend the installation of a least one pan lysimeter for performance monitoring, at a minimum.

Basis

Appendix A to 10 CFR Part 40, Criterion 5B(6) requires, in part, that constituents will not pose a substantial present or potential hazard to human health or the environment.

[13] Albright, W., Benson, C., Gee, G., Roesler, A., Abichou, T., Apiwantragoon, P., Lyles, B., and Rock, S. (2004). *Field Water Balance of Landfill Final Covers*. J. Environ. Qual., 33(6), 2317-2332.

Com 4-4

Provide a more comprehensive set of modeling results and discussion.

Discussion

Chapter 4.1.5 of the LAR provides the results of the water balance predictions. From 500 to 550-years, the annual percolation was 0.01 inches/year while the average annual precipitation was 10.32 inches/year (262.1 mm/year). Over the entire 1000 years, the average annual percolation was 0.02 inches/year (0.51 mm/year) while the average annual precipitation was 10.80 inches/year (274.3mm/year). The ranges of average annual percolation and precipitation ranges should also be provided.

Chapter 4.1.5, Figure 7, of the LAR plots the results of the SEEP/W model for the 500 to 550-year period including cumulative percolation, surface runoff, ET, soil water storage, as well as cumulative precipitation. The NRC staff requests this data in tabulated format; preferably as an electronic excel spreadsheet. The model results are difficult to review as presented in Chapter 4.1.5, Figure 7. This set of results should include the following output: precipitation, soil water storage, ET, and runoff and percolation (at depths corresponding to the base of the ET cover and the base of the radon barrier). The results for time periods other than 500 to 550-years should be provided. Specifically, results and associated discussions should focus on the performance of the cover during the wettest years of the model simulation. For example, ET Cover Guidance developed by the CDPHE (2013) used the precipitation to potential evapotranspiration ratio to determine the design year, which is based on a study by Apiwantragoon (2007).[14] The State of Utah (Utah Admin. Code 315-303-3) requires numerical models of alternative covers be run to show the expected performance of the cover: (1) under normal precipitation for a period of time until stability has been reached; and (2) during the five wettest years on record at the site or the nearest weather station.

Basis

Appendix A to 10 CFR Part 40, Criterion 5B(6) requires, in part, that constituents will not pose a substantial present or potential hazard to human health or the environment.

Com 4-5

a) Discuss the uncertainty associated with the various SEEP/W model input parameters (e.g., time-step, material properties, and vegetation parameters).

b) Assess the sensitivity of the water balance modeling to input parameter uncertainty discussed in a).

c) Evaluate the performance of the ET cover in response to alternative scenarios including the potential impacts of climate change (e.g., changes in vegetation cover and rooting depth over time; impacts of drought and/or fire associated with a significant amount of vegetation dieback; exceptionally wet years and extreme precipitation events).

[14] Apiwantragoon, P. (2007). *Field Hydrologic Evaluation of Final Covers for Waste Containment*, PhD Dissertation, University of Wisconsin, Madison, WI.

Discussion

Benson (2010)[15] states that water balance predictions can be "very sensitive to the material properties input by the user, the boundary conditions that are applied, and the characteristics of the constitutive relationships that are selected." Benson (2010) emphasizes that model predictions are not necessarily realistic and in some cases may deviate appreciably from reality. While the LAR Chapters 4.1 provides the inputs and results of the SEEP/W water balance model, there is no discussion of any sensitivity analyses performed by varying input parameters or evaluating alternative scenarios. Sensitivity studies are an essential component of any modeling effort; they can be helpful to assess the impacts of input parameter uncertainty and alternative model scenarios. While addressing parts a), b), and c) of this Com, Coms 4-6, 4-7, 4-8, and 4-9 should also be considered.

Basis

Appendix A to 10 CFR Part 40, Criterion 5B(6) requires, in part, that constituents will not pose a substantial present or potential hazard to human health or the environment.

Com 4-6

Justify using a value of -2 for the pore interaction parameter for the gravel-amended soil layer or rerun the analysis with a revised value(s).

Discussion

Chapter 4.1.1, Table 2, of the LAR summarizes the soil hydraulic properties used in the SEEP/W analysis. A value of -2 for the pore interaction parameter was assigned to all cover layers, which is recommended for fine-grained soils (Albright et al., 2010). As such, justification is needed for using this value for the gravel-amended soil layer.

Basis

Appendix A to 10 CFR Part 40, Criterion 5B(6) requires, in part, that constituents will not pose a substantial present or potential hazard to human health or the environment.

Com 4-7

Justify using a value of 40 percent for the soil-cover fraction for the entire water balance modeling simulation period or rerun the analysis with a revised value(s).

Discussion

Chapter 4.1.3, Table 6, of the LAR provides a summary of the vegetation data used as inputs to the SEEP/W model, which shows that a soil-cover fraction of 40 percent was used in the model. In addition, Chapter 3.5 of the LAR Appendix C states that "plant cover for the revegetated ET cover is expected to average 40 percent in average years with 20 percent coming from shrubs

[15] Benson, C. (2010). *Prediction in Geoenvironmental Engineering: Recommendations for Reliable Predictive Modeling* in *GeoFlorida 2010, Advances in Analysis, Modeling and Design*. Geotechnical Special Publication No. 199, Fratta, D., Puppula, A., and Muhunthan, B., eds., ASCE, Reston, VA, 1-13.

and 20 percent coming from grasses." However, according to the Vegetation Characterization and Biointrusion Surveys report for the Church Rock Mill site (Cedar Creek, 2014), the shrubland vegetation community in the site vicinity is the projected late-successional or climax community; this community is expected to inhabit the site for the 50- to 1,000-year timeframe. Furthermore, Chapter 2.3.1 of this report states that the bareground exposure was 47.4 percent for the shrubland analog community, while the vegetation cover was 24.8 percent. As such, justification for using a value of 40 percent for the soil-cover fraction for the entire model simulation period should be provided.

Basis

Appendix A to 10 CFR Part 40, Criterion 5B(6) requires, in part, that constituents will not pose a substantial present or potential hazard to human health or the environment.

Com 4-8

Assess the impacts of using a shallower root depth in the water balance modeling.

Discussion

Chapter 4.1.3, Table 6, of the LAR specifies the root depth for the cover modeling was set at a depth of 3.25', which extends 0.91' into the radon barrier. The impacts of using a shallower root depth should be assessed due to the highly compacted radon barrier limiting deeper root penetration (at least initially).

Basis

Appendix A to 10 CFR Part 40, Criterion 5B(6) requires, in part, that constituents will not pose a substantial present or potential hazard to human health or the environment.

Com 4-9

Justify the use of a leaf area index of 1.14 as an input to the SEEP/W model or rerun the analysis with a revised value(s).

Discussion

Chapter 4.1.3 of the LAR, and Chapter 3 of Appendix C, discuss the vegetation parameters used in the SEEP/W model. The SEEP/W model used a leaf area index (LAI) of 1.14, which was based on the reclaimed community from Church Rock Mill site. The Cedar Creek report for the Church Rock Mill site (2014) calculated LAI by sampling the following analog sites representing the projected ecological succession for the Church Rock Mill site: 1) reclaimed community: 0-50 years, 2) grassland community: 25–100 years, and 3) shrubland community: 50–1,000 years.

The reclaimed community exhibited a peak LAI of 1.14 (perennial species accounted for 0.88 of the total; annual species accounted for the remaining 0.26). The grassland community exhibited a peak LAI value of 0.80 (perennial species accounted for 0.71 of the total; annual species account for 0.09). The shrubland community exhibited a peak LAI of 0.65 (perennial species

account for 0.61 of the total; annual species account for 0.04). These results show that as the vegetation communities continue through ecological succession, the LAI decreases. Chapter 3.1 of the LAR Appendix C, as well as Chapter 3.3 of Cedar Creek (2014), state that "LAI contribution from annual species is inappropriate for use in modeling long-term vegetative conditions due to their inconsistency on an annual basis."

Based on the discussion provided in the preceding paragraphs, the requested justification should address the LAI values associated with the predicted vegetation succession. The recommendation by Cedar Creek (2014, LAR Appendix C) regarding use of the LAI contribution from annual species should also be addressed. Note that Com 3-7 requests justification for the use of the reclaimed plant community from the Church Rock Mill site as a reference site for the proposed Homestake ET cover vegetation.

Basis

Appendix A to 10 CFR Part 40, Criterion 5B(6) requires, in part, that constituents will not pose a substantial present or potential hazard to human health or the environment.

Com 4-10

Justify the long-term moisture content of the radon barrier soils for the top slope of the final cover system or rerun the analysis with a revised value(s).

Discussion

The final radon barrier design for the large tailings pile based its radon flux calculation on an average long-term moisture content of 15.5 percent, with the understanding that material from the North Borrow area would be used for the radon barrier on the top slope (see final radon barrier design, pdf page 27 and Table 3-13 on pdf page 38).[16] The NRC staff understands that HMC does not plan to alter the radon barrier design for the top slope. With the change to an ET cover system, and the potential for roots to penetrate into the radon barrier given the relatively low amount of cover soil, it is not clear to the NRC staff if the long-term moisture content assumption for the radon barrier on the top slope remains valid.

Basis

Appendix A to 10 CFR Part 40, Criterion 6(1) establish the radon flux standards for tailings piles. The regulation requires that the NRC staff has reasonable assurance that the design will limit radon flux to 20 pCi/m^2s and be effective for 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years. NUREG-1620, Chapters 5.1.2 and 5.1.3 provide guidance on this issue.

Com 4-11

a) Explain approach used to design erosion resistance for the top slope, the ability to resist gully formation, and how the design will avoid the need for long-term maintenance.

b) Clarify the procedures for placement of the rock/soil mixture in the narrative discussion.

[16] Agencywide Documents Access and Management System (ADAMS) Accession No. ML20085M655

Discussion

In Appendix E of the LAR, the calculations for erosion control are based on a 2 percent slope with a length of approximately 736'. The calculation identified a rock with a D_{50} of 1.2 inches for the rock/soil mixture that comprises the uppermost layer of the final cover system. The proposed cover design in Chapter 4.0, Figure 3, calls for a 9-inch-thick rock/soil layer with a D_{50} of 1.25 inches for the rock. Based on Figure 3, the NRC staff assumes the soil and rock will be mixed evenly through the 9-inch-thick layer (1/3 gravel, 2/3 soil as measured by volume). The narrative discussion in Chapter 4.4 of the LAR gives the impression that the rock will be a continuous layer. The narrative discussion should clarify placement of the rock/soil mixture. Additionally, the LAR does not address the potential for gully formation on the top slope. A rock/soil mixture may not be capable of avoiding gully formation in the cover soils, especially given the long slope lengths and the lack of rock-to-rock contact (if the soil and rock is mixed evenly throughout the 9-inch-thick layer). It may be necessary to oversize the rock to so that the potential for propagation of gullies is minimized. Formation of gullies may require maintenance to prevent erosion into the underlying soil layers. This is contrary to the goal of a maintenance free design envisioned by the regulations in 10 CFR Part 40, Appendix A.

Basis

Appendix A to 10 CFR Part 40, Criterion 6(1) requires that the NRC staff has reasonable assurance that the design be effective for 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years. Additionally, Criterion 12 requires that the isolation of tailings not require ongoing active maintenance is not necessary to preserve isolation.

Com 4-12

Additional details are needed in the engineering drawings to show how the proposed ET cover will tie-in with the existing rock cover at the side slopes.

Discussion

The engineering drawings contain one detail (detail A on sheet C-7) that shows the area where the cover systems meet at the crest of the side slope. However, the detail is not clear on where the 4.7-inch rock starts/stops in relation to the crest of the side slope. It is also not clear to the NRC staff that the minimum required radon barrier thickness will be maintained at the transition from the side slope to the top slope.

Basis

Appendix A to 10 CFR Part 40, Criterion 4(d) requires that designs avoid creating concentrated surface runoff. Additionally, Criterion 6(1) requires that the NRC staff has reasonable assurance that the design be effective for 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years. Finally, Criterion 12 requires that the isolation of tailings not require ongoing active maintenance is not necessary to preserve isolation. Concentrated runoff may require maintenance in the long-term.

Com 4-13

Provide the required input parameters that were used in the Wind Erosion Prediction System calculations.

Discussion

The LAR Chapter 4.4.3 describes the analyses that were performed for the Homestake LTP to estimate the net soil loss per acre per year. The LAR states that specific inputs were selected based on the site location (Latitude: 35.24° N, Longitude:107.86° W, and elevation of 6500 ft) and also that a sandy loam with 33 percent for the volume percent of the rock fragments was input into the model. However, none of the required model input parameters are listed (including particle-size information) in the LAR. Chapter 4.1.1. of the LAR states that the gravel-amended soil layer will be constructed with topsoil stripped from the borrow area that has characteristics consistent with the soil from TP1-A (0'-4'). Furthermore, according to Table 2 in Appendix C of the LAR, the soil of TP1-A is classified as a clay soil according to the USDA textural classification system, rather than a sandy loam as characterized in the wind erosion analysis.

Basis

Appendix A to 10 CFR Part 40, Criterion 4(d) requires that a full self-sustaining vegetative cover must be established or rock cover employed to reduce wind and water erosion to negligible levels.

Com 4-14

Provide discussion regarding the status of the monitoring wells that currently exist on top of the LTP.

Discussion

There are several monitoring wells located on top of the LTP. However, there does not appear to be discussion in the LAR regarding the status of the wells (i.e., whether the wells are to remain or be removed) and what impact, if any, HMC anticipates if the wells remain (e.g., preferential pathways along casings).

Basis

Appendix A to 10 CFR Part 40, Criterion 5B(6) requires, in part, that constituents will not pose a substantial present or potential hazard to human health or the environment. In addition, Criterion 6(1) of Appendix A establishes the radon flux standards for tailings piles. The regulation requires that the NRC staff has reasonable assurance that the design will limit radon flux to 20 pCi/m^2s and be effective for 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years.

Com 5-1

In addition to specifying the test pit soils that will be used for the ET cover soil layers (as requested in Com 4-1), provide the target soil properties (i.e., 0 to 0.75' and 0.75' to 1.59' in Chapter 4.0, Figure 3, of the LAR).

Discussion

Laboratory testing was performed for geotechnical, hydraulic, and agronomic properties, which are documented in Appendices B1, B2, and C, respectively. Although some suitability ranges for the agronomic properties are presented in Table 1 and Figure 1 of the LAR Appendix C, the target soil properties for the ET cover are not clearly specified in the LAR. Target properties (and appropriate ranges) of the proposed ET cover soil layer should be specified. Furthermore, target soil properties should be specified in the Homestake LTP ET Cover Technical Specifications report, which is provided in Appendix F of the LAR.

The specified target properties should include the following: soil pH; $CaCO_3$ content; nitrogen, potassium, and phosphorous content; electrical conductivity; salt content; cation exchange capacity; clay content; soil texture (USDA); particle-size distributions and limits; porosity; Atterberg limits; bulk density.

Basis

Appendix A to 10 CFR Part 40, Criterion 4(d) requires that a full self-sustaining vegetative cover must be established or rock cover employed to reduce wind and water erosion to negligible levels.

Com 5-2

a) Specify the proposed ET cover compaction levels and any measures to prevent over-compaction of the soil during placement.

b) Provide justification for specifying a compacted soil density at the upper end of the range that is recommended in the literature.

Discussion

Figure C-7 of Appendix G, “Construction Drawings,” and Chapter 4.0, Figure 3 of the LAR shows that the soil cover from a depth of 0.75’ to a depth of 2.34’ will be compacted at 85 percent of maximum standard proctor dry density, while the radon barrier (at a depth from 2.34’ to 4.59’) will be compacted to 100 percent of maximum standard proctor dry density. No specifications are provided for the surficial gravel-amended soil in Chapter 4.0, Figure 3. In comparison, Chapter 4.1.1, Table 2, of the LAR is similar, but specifies that the upper 0.25’ of the radon barrier will be compacted to 95 percent of maximum standard proctor dry density. Chapter 1.11, “Compaction Requirements,” shows that the soil cover (i.e., approved borrow and admixture layers) will be compacted at 88-93 percent of maximum standard proctor dry density at plus or minus 2 percent of optimum moisture content.

CDPHE (2013) notes that “for most soil textures, the growth-limiting bulk density is in the range of about 83 to 88 percent of the maximum standard Proctor density (American Society for Testing and Materials, D698).” Justification for specifying a compacted soil density at the upper end of the recommended range should be provided. Details regarding the placement of this layer to prevent over-compaction should also be provided. For example, Interstate Technology

and Regulatory Council (Interstate Technology Regulatory Council (ITRC), 2003))[17] and CDPHE (2013) recommend placing cover soil in relatively thick lifts (i.e., 18" to 24") to control compaction along with the use of low-ground-pressure equipment during soil placement. In addition, keeping the moisture below the soil's optimum moisture content to prevent over-compaction is also recommended.

Basis

Appendix A to 10 CFR Part 40, Criterion 4(d) requires that a full self-sustaining vegetative cover must be established or rock cover employed to reduce wind and water erosion to negligible levels.

[17] ITRC, 2003, Technical and Regulatory Guidance for Design, Installation, and Monitoring of Alternative Final Landfill Covers: Interstate Technology and Regulatory Council, Alternative Landfill Technologies Team, Washington, D.C., ALT-2, 125 p.

Homestake Mining Company. U.S. Nuclear Regulatory Commission Acceptance Review and Comments on the Large Tailings Pile Evapotranspiration Cover License Amendment Request DATE September 28, 2022

DISTRIBUTION:
JMarshall, NMSS/DUWP
ARoberts, NMSS/DUWP

ADAMS Accession No.: Ltr ML22256A283

OFFICE	NMSS/DUWP /URMDB	NMSS/DUWP/RTAB	NMSS/DUWP /URMDB	RES/DRA/FXHAB
NAME	RLinton *RL*	GAlexander *GA*	DMandeville *DM*	STabatabai *ST*
DATE	Sep 13, 2022	Sep 15, 2022	Sep 15, 2022	Sep 16, 2022
OFFICE	NMSS/DUWP /URMDB	NMSS/DUWP /URMDB		
NAME	RVon *RV*	RLinton *RL*		
DATE	Sep 26, 2022	Sep 28, 2022		

OFFICIAL RECORD COPY